Chapter 3:
Planning for Long-Term Stewardship

Granite Marker Plot M, in the Palos Forest Preserve Cook County Forest Preserve District. This granite block marks the location of buried radioactive materials that include wastes relocated from Enrico Fermi's uranium-graphite pile at the University of Chicago. The Fermi pile was built for the Manhattan Project in 1942 and achieved the world's first man-made self-sustaining nuclear chain reaction. The caption on the marker reads: "CAUTION - DO NOT DIG Buried in this area is radioactive material from nuclear research conducted here 1943-1949. The burial area is marked by six corner markers 100 ft. from this center point. There is no danger to visitors. U.S. Department of Energy 1978." *Plot M, Palos Forest Preserve, Cook County Forest Preserve District, 20 miles Southeast of Chicago, Illinois, November 1995.*

The Department has made significant progress in its cleanup program. Workers have completed environmental restoration of hundreds of contaminated release sites across the nation. Millions of cubic meters of waste have been disposed, much of it in independently regulated commercial facilities. The Department has opened and begun disposition of radioactive transuranic (i.e., plutonium-contaminated) waste at the nation's first deep geological repository – the Waste Isolation Pilot Plant in New Mexico (Exhibit 12). The enduring success of all these activities will depend on effective long-term stewardship.

Running a long-term stewardship program over the extended periods of time discussed in Chapter 1 is an unprecedented task with many uncertainties. No existing institution has yet acquired experience in protecting public health and the environment from hazards for such a long period of time.

Although statutory and regulatory requirements provide guidelines for a blueprint for long-term stewardship, it is not clear that existing requirements anticipate the measures that may be needed in the future for long-term stewardship. Nor do they ensure the development of effective implementation strategies. The challenges ahead may be

Special Casks for Shipping Transuranic Waste. These demonstration models are similar to those being used to ship transuranic waste to the Waste Isolation Pilot Plant in New Mexico. Each of these Transuranic Package Transporter (TRUPACT-II) casks can hold fourteen 55-gallon drums. A window in the center model cask shows mock waste drums cut open to reveal typical constituents of transuranic waste. *Waste Isolation Pilot Plant, New Mexico, February 1994.*

Underground Transuranic Waste Disposal Room. This room, excavated in 1986, is the first of 56 chambers to be excavated at the Waste Isolation Pilot Plant. It is 300 feet long, 33 feet wide, and 13 feet tall and can hold six thousand 55-gallon drums of transuranic waste. It lies 2,150 feet below the surface of the earth in an ancient stable salt formation. *Room 1 of Panel 1, Waste Isolation Pilot Plant, New Mexico, February 1994.*

Exhibit 12: The Waste Isolation Pilot Plant (WIPP)

After years of research, construction and regulatory reviews, DOE began disposing of waste at WIPP in March 1999. WIPP is the world's first engineered geologic repository for radioactive waste disposal. It will dispose of much of the transuranic waste from the research and production of nuclear weapons that has been stored at numerous locations throughout the United States.

WIPP is located in southeastern New Mexico in an ancient stable salt formation 2,150 feet underground. Its disposal location was selected in part because the salt formation is stable and has "plastic" properties; in time, the salt will surround and contain the waste. The site was evaluated by EPA and the National Academy of Sciences and was determined to be suitable for permanent disposal of waste based on its ability to isolate the waste safely for at least 10,000 years.

WIPP was certified by EPA based on extensive technical documentation about the site provided as part of the regulatory process. Current estimates are that it will take at least 35 years for WIPP to be filled to its capacity. It will be shut down over a 10-12 year period, then will be carefully monitored for another two or three generations. In about 2099, the site will be closed permanently and marked to warn future generations to keep out. In response to regulatory requirements for passive institutional controls, DOE submitted designs for markers that identify the WIPP site and convey information about the disposal system's design and contents. The conceptual design includes the following elements:

A massive berm 10 meters (33 feet) tall and 30 meters (98 feet) wide at its base will surround the surface of the repository. To decrease collection of precipitation in the enclosed area of the berm, drainage paths will be built at approximately 100 meter (328 foot) intervals. Large permanent magnets buried at intervals in the berm will give the structure a distinctive magnetic signature. These magnets will measure approximately 1 meter (3.2 feet) long and 0.5 meters (1.6 feet) square in cross-section and will produce a signal detectable with current airborne detection equipment.

A series of 16 granite monuments, each standing 6.7 meters (22 feet) above ground and buried 6.7 meters (22 feet) into the soil, will be placed along the inside perimeter of the berm. A warning of the dangers of the materials entombed below will be inscribed in seven languages: English, French, Spanish, Chinese, Russian, and Arabic (the six official United Nations languages), and Navajo.

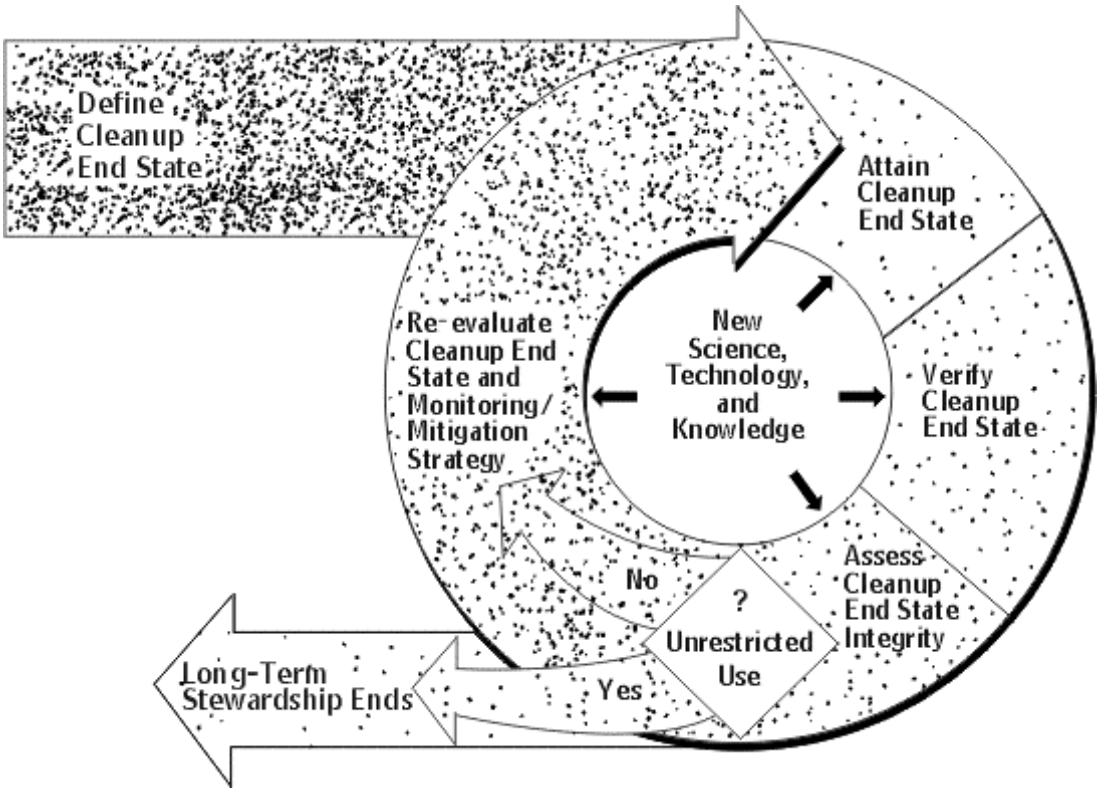
Several thousand small markers, constructed of three different materials (granite, aluminum oxide, and fired clay) will be buried at random intervals within the repository footprint and in the berm. Each of the markers will have a warning message in one of the seven languages used on the monuments.

Three granite-walled information centers with four exterior walls, seven parallel interior information walls, and no roof will be inscribed with more detailed warnings in tables, figures, diagrams, and maps. One will be built above ground without a roof to permit observation of the messages in natural light. The others will be buried. One information room will be buried within the center of the southern section of the berm. The final information room will be buried 160 meters (525 feet) north of the berm on a line between the above ground information center and the disposal area. The location of the buried information rooms will be documented in records located off-site in archives and record centers and in the above-ground information center.

technical, economic, institutional, cultural, environmental, or of a type not yet anticipated. The uncertainties associated with long-term stewardship of DOE sites include the nature of the hazards, the effectiveness of monitoring and maintenance of barriers and institutional controls, and the cost of these activities. Other unknowns include the availability of adequate technologies, the future development of better remedial and surveillance technologies, long-term funding and other resources, and long-term management of data. These uncertainties and unknowns make it difficult to shape definitive plans for the many years that stewardship will be needed. Exhibit 13 illustrates how science and technology will affect cleanup end state and long-term stewardship strategies over time.

The long-term stewardship challenges facing DOE also include the disposition of "materials in inventory." The Department is responsible for managing a variety of materials resulting from the operation of large production facilities and numerous laboratories that acquired and produced enormous amounts of chemicals, metals, radioactive substances, and other materials. As described in the report of the

Exhibit 13: Changing Knowledge and Technology: The Dynamic Nature of Long-Term Stewardship



The relationship between cleanup, end states, and long-term stewardship requirements outlined in this report represents a static projection, or snapshot in time, based on existing knowledge and technologies. However, technologies will improve over time, creating opportunity for improved efficiencies in both the cleanup and stewardship phases. Efforts to accelerate cleanup will more rapidly reduce risks posed by hazards at DOE's sites and also will reduce ongoing maintenance costs significantly. This, in turn, should make more resources available for investments in new science and technologies.

Changing knowledge and technology will affect cleanup goals and strategies. New scientific understanding or regulatory changes may affect end state requirements such as residual contamination levels. New technologies may provide more economical approaches to achieve the same end state or may allow currently infeasible end states to be achieved. A key focus of efforts to attain different end states will be the ability to reduce long-term stewardship requirements.

Changing knowledge and technology will affect long-term stewardship activities. New scientific understanding and new technologies may lead to more economical and effective strategies for verifying that a desired end state actually is achieved, for monitoring the long-term integrity of the end state, and for developing and implementing contingency plans to anticipate and mitigate failures. Changes in information technology will affect strategies for generating, preserving, and providing access to critical long-term stewardship data.

Changing knowledge and technology will require periodic re-evaluation of existing end states. If history is our guide, we can expect profound changes in human economics, culture, science, and technology over time. For example, patterns of land and other resource use at and near long-term stewardship sites will change, and knowledge and technology will evolve in a variety of fields. At some point in the future, existing engineered controls will begin to fail unless additional actions are taken. At the same time, new technology can translate to more robust engineered controls requiring less intensive long-term stewardship activities. A critical part of long-term stewardship will be a systematic re-evaluation and modification of existing end states over time to ensure that developments in science, technology, and other knowledge are incorporated into long-term stewardship strategies.

Maintenance of Uranium Hexafluoride Cylinders. A worker at the Oak Ridge Reservation uses ultrasound to evaluate the effects of corrosion on a steel cylinder containing depleted uranium hexafluoride — the material left over from the uranium enrichment process. DOE owns over 46,000 cylinders of this material weighing 10 to 14 tons each. By mass, depleted uranium makes up over 70 percent of the Department's Materials in Inventory. After decades of storing this material, the Department is now undertaking a conversion project to stabilize the uranium hexafluoride for final disposition. *K-1066-K Cylinder yard, K-25 Site, Oak Ridge, Tennessee January 1994.*

Materials in Inventory Initiative (DOE 1996a), there are as yet no feasible disposition options for many of these materials, including both nuclear materials (e.g., uranium hexaflouride, U-233, spent nuclear fuel) and non-nuclear materials (e.g., reactive sodium, contaminated metals). Managing these materials often involves stabilization and long-term storage until final disposition options become available. Much like the entombed reactors placed in interim storage until final disposition is possible, these materials will require years of long-term management and control at DOE sites.

Despite these uncertainties, the Department is carrying out its stewardship obligations and planning for future stewardship efforts. As the Department accelerates cleanup, the need for post-cleanup stewardship is also accelerated. Because stewardship is already underway at some sites and will soon be at others, DOE needs to ensure that there is a smooth transition from cleanup to stewardship. To succeed, this planning must be done in consultation with Federal agencies, Tribal Nations, state and local governments, and other stakeholders.

Personnel at DOE headquarters and many field sites are now examining future stewardship activities. In addition, states and Tribal Nations, through the State and Tribal Government Working Group (STGWG) and local community groups and coalitions (such as the Energy Communities Alliance and the Rocky Flats Coalition of Local Governments), are working with the Department to raise long-term stewardship issues and determine the best ways to address them. Other organizations, such as the National Academy of Sciences, the

Exhibit 14: Long-Term Stewardship Recommendations

Long-term stewardship is recognized as an issue not only within DOE, but also outside the Department. Several organizations, including several stakeholder and advisory organizations, are actively working on issues related to long-term stewardship at DOE sites. These organizations have developed reports, established subcommittees on long-term stewardship, and in several cases, provided specific written recommendations to the Department for long-term stewardship both at the site-specific level, as well as the national level. For example, the Environmental Management Advisory Board (EMAB) and the State and Tribal Government Working Group (STGWG) address stewardship at a national level. Two other organizations, the Oak Ridge Reservation End Use Working Group (EUWG) and the Rocky Flats Stewardship Dialogue Planning Group, address stewardship issues more focused at the site-specific level. The EMAB, STGWG, and EUWG submitted specific recommendations to DOE that address the following three themes:

- **Establishing long-term stewardship plans at the site level;**
- **Developing or clarifying a DOE-wide long-term stewardship program or organization; and**
- **Enhancing long-term stewardship implementation.**

In addition, each organization provided specific details on how DOE should pursue these recommendations. Imbedded in the supporting information provided were additional recommendations for the Department to pursue. Although these ideas were implied in each of the organizations recommendations, they may have only been specifically addressed by one or two of the reports. Other recommendations addressed by one or more of the organizations included:

- **Identifying the appropriate data for collection, maintenance, and dissemination of stewardship information.**
- **Ensuring local government and stakeholder involvement in developing transition and long-term stewardship implementation plans.**
- **Fully explaining and quantifying the required long-term cost and funding commitment required for long-term institutional controls.**
- **Making stewardship requirements an integral part of all CERCLA decision documents.**

Although the Rocky Flats Stewardship Dialogue Planning Group did not include specific recommendations to the Department, this organization is addressing stewardship needs at the Rocky Flats Environmental Technology Site, and is beginning to frame the critical issues and concerns associated with stewardship at the site. For more detail on the specific recommendations provided by these organizations, please refer to the documents listed in the Reference section in the back of this report. Copies of these documents are available on the DOE Long-term Stewardship Information Center website at *www.em.doe.gov/lts*.

Environmental Law Institute, and Resources for the Future are also considering stewardship issues, as are some of the national laboratories. Some of these efforts are highlighted in Exhibit 14.

The Department has begun planning for long-term stewardship through the process of developing the *Paths to Closure* document and this companion document, *From Cleanup to Stewardship*, as well as through the accumulated experience of carrying out long-term stewardship in the field. This planning is still in its early stages; the Department recognizes that more research and analysis are needed to ensure reliable and cost-effective stewardship at a programmatic level. The follow-on long-term stewardship study, pursuant to the terms of the 1998 Settlement Agreement, is the next step in this planning process (see Appendix A for information on the Settlement Agreement).

The long-term stewardship study will describe the scope of DOE's long-term stewardship responsibilities, the status of current and ongoing stewardship obligations, activities, and initiatives, and the plans for future activities; it will analyze the national issues DOE needs to address in planning for and conducting long-term stewardship activities; and it will promote information exchange on long-term stewardship among DOE, Tribal Nations, state and local governments, and local citizens. The study will <u>not</u> be a National Environmental Policy Act document or "decision document;" it will not identify or address site-specific issues except as examples in the context of national issues; nor will it address issues

specific to nuclear stockpile stewardship, other activities related to national security, or the Central Internet Database required by the Settlement Agreement.

Development of the long-term stewardship study will begin with a public scoping process. Scoping includes opportunities for interested parties to learn about the goals of the study, comment on what issues or topics the study should consider, and discuss key elements of the study with DOE staff. As there is no predetermined scope for the study, broad public input is essential. Based on the results of the scoping process, DOE will prepare a draft study that is anticipated to be released for public comment in Spring 2000. The public comment process will allow comprehensive public comment on the draft study. After the public comment period, DOE will prepare a final study.

What Might Future Generations Question?

In 1995, the Department published a document in which it asked, "What Might Future Generations Question?" (DOE 1995a):

> *A question that haunts many who are involved in the Department's environmental management program is: "What are we doing today that will prompt another generation to say, 'how could those people – scientists, policymakers, and environmental specialists – not have seen the consequences of their actions?'" . . . No one can yet know what these future questions will be, much less the correct answers. Nonetheless, part of the inheritance of the people working on this new enterprise is desired to look to the future and anticipate those questions.*
>
> *If the intellectual giants of the Manhattan Project could not foresee all of the implications of their actions, it is particularly daunting for those involved in this new undertaking to consider what they might be missing in taking on the equally challenging task of cleaning up after the Cold War.*

Perhaps a question for current and future generations might be "How do we ensure effective long-term stewardship of sites with residual waste and contamination?" The question has technical, financial, cultural, and institutional elements. We cannot today provide complete answers to it. But, as we conclude cleanup operations and dispose of waste, we will need to work together on individual, community, state, and national levels to address this question.

For additional information on DOE's long-term stewardship initiatives, including the full text of this report and the appendices, please log on to *www.em.doe.gov/lts*. This web address also includes reports prepared about DOE stewardship activities by entities outside of the Department. For written copies of these or other long-term stewardship materials, please call 1-800-7-EMDATA (1-800-736-3282).

References

Environmental Management Advisory Board, Long-Term Stewardship Committee. 1998. *Long-Term Stewardship Committee Recommendations to the Full Environmental Management Advisory Board,* October 8, 1998.

ICF Kaiser Consulting Group (ICF). 1998. *Managing Data for Long-term Stewardship.* Report prepared for EM Office of Strategic Planning and Analysis, March 1998.

Joint Stipulation. 1998. Natural Resources Defense Council, et. al. v. Richardson, et. al., Civ. No. 97-963 (SS).

Livingstone, Steve, Bashaw, Janet, and Powell, Elizabeth, *Moving from Cleanup to Stewardship,* Waste Management '98, Sesson 62, Tuscon, Arizona, March 1-5 1998

Livingstone, Steve and Hegner, Robert, *Managing Data for Long-Term Stewardship,* Waste Management '98, Session 62, Tuscon, Arizona, March 1-5 1998.

Memorandum of Understanding (MOU). 1999. *Memorandum of Understanding between the U.S. Department of Energy and the U.S. Army Corps of Engineers Regarding Program Administration and Execution of the Formerly Utilized Sites Remediation Action Program (FUSRAP)*, March 17, 1999.

National Conference of State Legislatures. 1999. *Closure for the Seventh Generation: A Report from the Stewardship Committee of the State and Tribal Government Working Group*, February 1999.

National Research Council. 1988. *Improving Risk Communication.* National Academy Press, Washington, DC.

Oak Ridge Reservation End Use Working Group. 1998. *Stakeholder Report on Stewardship*, July 1998.

Performance Agreement (Revised Final Performance Plan). 1999. *Performance Agreement Between the President of the United States and the Secretary of Energy. Fiscal Year 1999*.

Rocky Flats Stewardship Dialogue Planning Group. 1999. *Beyond Closure: Stewardship at Rocky Flats,* April 1999.

Rudzinski, Suzanne, Sykes, Merle and Dahling, Peter. *The Impact of Excess Facility Disposition on Near-Term Budgets and Long-Term Infrastructure Planning in the U.S. Department of Energy.* Waste Management '98, Session 16, Tuscon, Arizona, March 1-5 1998.

U.S. Department of Energy (DOE). 1995a. *Closing the Circle on the Splitting of the Atom: The Environmental Legacy of Nuclear Weapons Production in the United States and What the Department of Energy is Doing About It*, January 1995 (reprinted January 1996).

U.S. Department of Energy (DOE). 1995b. *Estimating the Cold War Mortgage: The 1995 Baseline Environmental Management Report (*Volumes 1, 2, & 3), DOE/EM-0232, March 1995.

U.S. Department of Energy (DOE). 1996a. *Taking Stock: A Look at the Opportunities and Challenges Posed by Inventories from the Cold War,* DOE/EM-0275, January 1996.

U.S. Department of Energy (DOE). 1996b. *Charting the Course: The Future Use Report*, DOE/EM-0283, April 1996.

U.S. Department of Energy (DOE). 1996c. *The 1996 Baseline Environmental Management Report* (Volumes 1, 2, & 3), DOE/EM-0290, June 1996.

U.S. Department of Energy (DOE). 1997a. *Linking Legacies: Connecting the Cold War Nuclear Weapons Processes to their Environmental Consequences*, DOE/EM-0319, January 1997.

U.S. Department of Energy (DOE). 1997b. *Decontaminating Commercial Facilities for Reuse on DOE's FUSRAP Program*. DOE Oak Ridge Operations Office, September 1997.

U.S. Department of Energy (DOE). 1997c. *Cross-Cut Guidance on Environmental Requirements for DOE Real Property Transfers.* Office of Environmental Policy and Assistance RCRA/CERCLA Division, DOE/EH-413/9712. October 1997.

U.S. Department of Energy (DOE). 1998a. *Accelerating Cleanup: Paths to Closure*, DOE/EM-0362, June 1998.

U.S. Department of Energy (DOE). 1998b. *Planning for the Future: An Overview of Future Use Plans at Department of Energy,* October 1998.

Werner, James D., *Secrecy and Its Effect on Environmental Problems in the Military: An Engineers Perspective*, New York University Environmental Law Journal, Vol. 2 No. 2, 1993.

Index of Site-Specific Photographs and Exhibits